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Thromboplastic Activity in the Tissues Adjacent to Hip Prosthesis—Preliminary Report

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Four cases with McKee-Farrar type of total hip replacement who showed late loosening were examined for tissue thromboplastin in the greater trochanter, the joint capsule and the fibrous pseudocapsule surrounding the prosthetic articulation at reoperation. Three cases were found to be sensitive to cobalt. The tissue thromboplastin concentrations in these tissues were increased in all cases, indicating that its concentration in the fibrous pseudocapsule was high more than 25 times as compared with the control capsules. Cobalt and chromium were found to have no accelerating effect on the tissue thromboplastin or thrombin activity up to a final concentration of 10^{-4} M. (Received February 2, 1978 and accepted April 28, 1978)

1 Introduction

Attention has been drawn to cobalt in implanted alloys as a possible cause of late loosening of hip prosthesis in patients without infection, inadequate implantation, or trauma. Increased metal concentrations in tissues adjacent to implanted metals have been described by Ferguson and associates[1]. Coleman and associates[2] have demonstrated that cobalt and chrome were present in the blood and urine after total hip replacement. Charosky and associates[3] have also demonstrated that most of the patients with total hip replacement failures showed metal particles in fibrous pseudocapsule intra- and/or extra-cellularly. Recently metal sensitivity has been considered as a cause of bone necrosis and loosening of the prosthesis in total joint replacement by Evans and associates[4]. They have found obliterative changes in the vascular supply by examination of the tissues adjacent to implanted prosthesis. Jones and associates[5] have described obliterative arteritis in the adjacent muscle of the hip joint removed from unsatisfactory cases.

The purpose of this short report is to elucidate a cause of obliterative changes in the adjacent tissues probably resulting in late loosening. Tissue thromboplastin contents in bone and joint capsule adjacent to the prosthesis in four cases of loosening (McKee-Farrar) are determined.

2 Material and methobs

Tissues were obtained from patients with late loosening at reoperation. The bone of the greater trochanter, the joint capsule and the fibrous pseudocapsule were used for the experiment. The samples were omitted when acute inflammatory reaction was confirmed histologically. The tissues taken from patients in whom no prosthesis had been inserted were used for controls. For tissue thromboplastin assay, tissue samples were washed with per cent saline solution and disintegrated after freezing. The

solution containing tissue thromboplastin was obtained by the method of Astrup and Sjølin[6]. The thromboplastin activity was measured following by Glas and Astrup[7]. The extract was centrifuged for minutes at 3000 rpm before assay. Cobalt chloride and chromium sulfate were used for cobalt and chromium, respectively. For the skin sensitivity test, 2 per cent cobalt chloride solution was used according to the method of Evans and associates[4]. Thrombin activity was measured by the method of Bergström and Lahnborg[8]. Bovine thrombin (about 67 NIH units per mg) was obtained from Sigma, USA.

3 Results

Results are shown in Table 1. All case who showed late loosening had the McKee-Farrar prosthesis for 6 to 19 months. Three out out of four cases were found to be sensitive to cobalt. The greater trochanter, the joint capsule and the fibrous pseudocapsule surrounding the prosthetic articulation were examined. The concentrations in the greater trochanter and the joint capsule were increased compared with the controls. The control value of the joint capsule, which is low in concentration, is in good agreement with the previous paper[6]. On the other hand, a highest level of tissue thromboplastin was measured in the fibrous pseudocapsule, suggestfng that there might be some correlation between cobalt sensitivity and level of tissue thromboplastin.

Table 1 *Tissue thromboplastin concentrations in patients with loosening of McKee-Farrar prosthesis*

Case number	Sex	Age	Diagnosis	Skin cobalt test	Tissue thromboplastin*		
					Bone	Capsule	Pseudo-capsule
1	Female	50	Osteoarthritis	Positive	0.7	0.3	3.0
2	Female	62	Osteoarthritis	Negative	1.0	0.2	2.6
3	Female	58	Osteoarthritis	Strongly positive	1.8	—	5.1
4	Female	61	Osteoarthritis	Strongly positive	1.1	0.7	3.8
Control**	Female	50–63	Osteoarthritis	Negative	<0.1	0.2±0.05	—

* Data presented in Table were expressed as thromhoplastin units per 1 mg protein extracted.

** Control value is the mean value of six individuals.

Cobalt and chromium released from a prosthesis have been determined in the adjacent tissues by many investigators[3~4]. Therefore, a direct effect of cobalt or chromium on thromboplastin activity in the control tissues has been examined to determine whether an enhancement of tissue thromboplastin activity is due to an increase in amount of tissue thromboplastin or an accelerating effect by cobalt or chromium. As a result these metals were found to have no accelerating effect on thromboplastin activity *in vitro* up to a final concentration of 10^{-4} M, which might be much higher concentration than that reported in the adjancent tissues. These metals also had no effect on effect on thrombin activity *in vitro*.

4 Discussion

Among many studies concerning late losening of the prosthesis such as thermal damage to bone in direct contact with cement[9], characteristic changes of implant bed[10], cobalt toxicity[5], and cobalt hypersensitivity[4], obliterative changes in the small vessels of the adjacent tissues have drawn a great deal of attention. Evans and associates[4] have emphasized that necrosis of bone and soft tissue adjacent to the prostheses, which leads to consequent loosening of the prostheses, took place following obliterative changes in their arteriolar supply. However, little is known about the mechanism of obliterative changes in the small vessels developing after total hip replacement.

It is well accepted that tissue thromboplastin contributes to fibrin formation through the activation of prothrombin which in turn aggregates platelets which is the primary event in the formation of arterial thrombi, and arterial endothelium has a highly thrombolytic activity with no or only traces of fibrinolytic activity[11]. Among the bone, the joint capsule and the fibrous pseudocapsule, a great amount of tissue thromboplastin was found in the fibrous pseudocapsule. This result indicates that most of the tissue thromboplastin generates in the newly developed tissue resulting from tissue reactions to the implanted materials. Tissue thromboplastin used in this study represents a more soluble type which is easily available in tissue. Therefore, tissue thromboplastin released may enter the adjacent tissues and the circulation. It is of interest that the joint capsule, which is the blood vessel-poor tissue, has less tissue thromplastin content that in the bone from the greater trochanter. Thus, locally released tissue thromboplastin may responsible for intravascular coagulation in the adjacent tissue. This phenomenon may occcur in bone and soft tissues opposed to the implanted prosthesis and leads to widespread tissue necrosis resulting in the occurrence of late loosening by making a gap between implanted foreign material and bone.

A close relationship between cobalt sensitivity and loosening of the prosthesis has been discussed on patients with unsatisfactory operative results[4,5]. The finding that cases being cobalt-sensitive were found to have a great amount of tissue thromboplastin in the fibrous pseudocapsule may suggest that cobalt sensitivity is closely related with generation of tissue thromboplastin. But, it is not clear whether tissue thromboplastin in the pseudocapsule was produced by cobalt released from the prosthesis or not. The reason why the pseudocapsule has a higher level of tissue thromboplastin remains to be investigated.

5 Conclusions

Four cases with McKee-Farrar type of total hip replacement who showed late loosening were examined for tissue thromboplastin in the greater trochanter, the joint capsule and the fibrous pseudocapsule surrounding the prosthetic articulation at reoperation. Three cases were found to be sensitive to cobalt. The tissue thromboplastin concentrations in these tissues were increased in all cases, indicating that its concentration in the fibrous psedocapsule was high more than 25 times as compared with the control capsules. Cobalt and chromium were found to have no accelerating effect on the tissue thromboplastin or thrombin activity up to a final concentration of 10^{-4} M.

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